Automotive system view requirements for networked video

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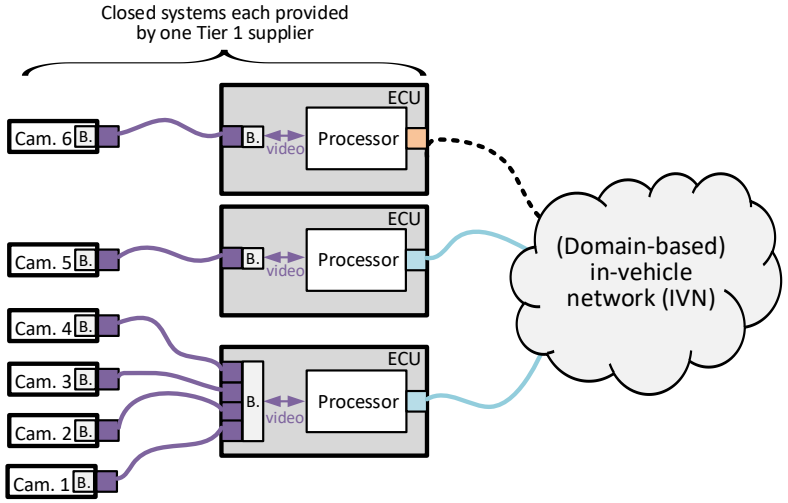
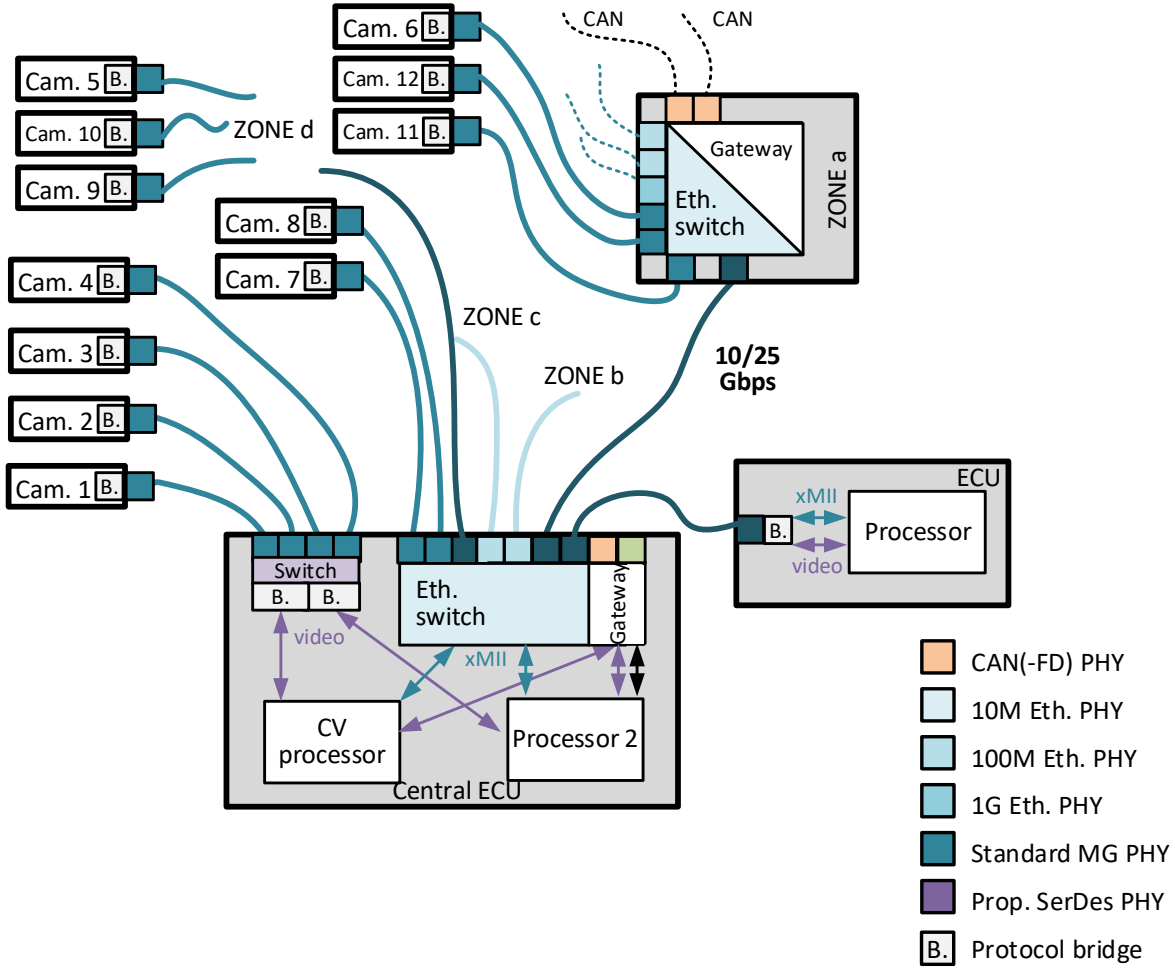
Motivation

- In long term video (cameras and displays) as well as other raw data sensors shall transmit their data via the main vehicle network and not in a separate video network.
- This presentation looks at the requirements coming from such an architecture from a system level point of view.
- It investigates timing requirements for sensor fusion looking at the whole image processing chain.
- It investigates requirements for favorable semi conductor solutions and their features helping a transition to a fully integrated zonal network.

Fully integrated zonal Network



Transition



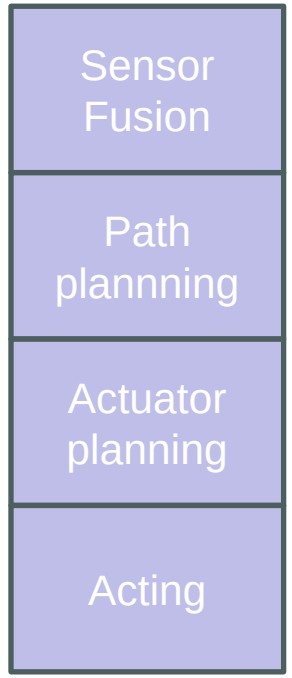
- Video will be part of the ETH Network and switched in Zones
- Low speed traffic is “freeriding” high speed connections
- Displays change the high speed direction compared to cameras

Camera to computer vision to actor

min 5ms (exposure)

New element adding latency?

min 10ms ~30ms (@ 30FPS)



- Latencies before sensor fusion already are in the range of 50ms or more.
- Total latencies from camera to actor easily exceed 100ms.
- Switches (as all other networking parts) add neglectable latency to that chain.
- The important part is very good time synchronization of all sensors to create all data at synchronized regular time slices and timestamp it. Jitter in transportation latency is neglectable.

Requirements in a fully zonal network

- Connection of cameras
  - Low cost (simple) and low power in camera module
  - Good time synchronization for sensor capture synchronization
  - Up to 15m with COAX and power over COAX
- Connection of displays
  - Different high speed direction than cameras (or sensor data in general)
  - Not as power sensitive
  - Occasionally, time synchronization for synchronizing screens
- Network
  - Cost effective (simple) solutions supporting flexibly both video directions with Phys integrated in the switches.
  - Power and start up sensitive

Looking into both video directions

FDD scheme

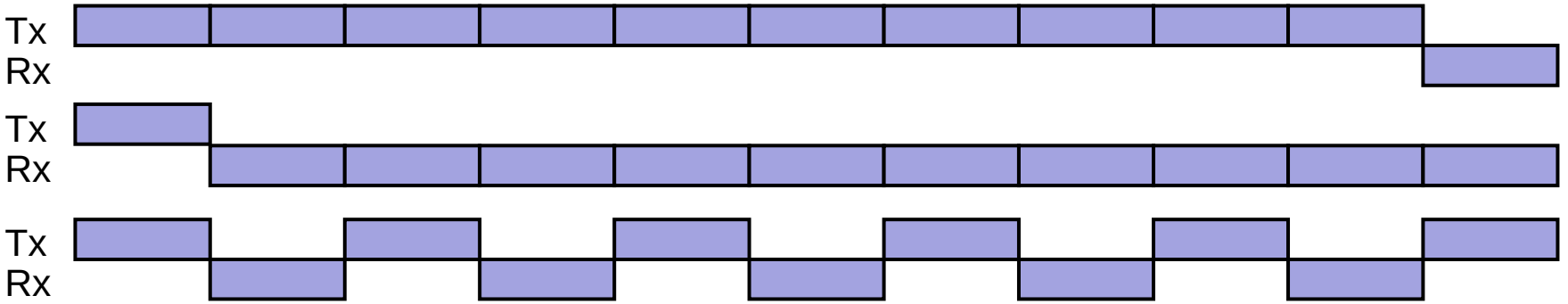
$f_{RX} \neq f_{TX}$

change of direction is change in frequency (and processing)

Echo canceler or filter (or both) needed

Direct access, no buffer necessary

TDD scheme



$f_{RX} = f_{TX}$ but little higher

change of direction is change in configuration

No Echo canceler needed

Symmetric use case possible by configuration

Small buffer necessary

Easier implementation for change of direction with TDD for (integrated) Phys

Conclusion

- Computing dominates whole video processing latency by several orders of magnitude over the communication latency
- Time synchronization and timestamping solves the issue of data age and compensates for jitter in data transport latency.
- Automotive aims for the most cost efficient solution fulfilling its requirements.
- TDD is most efficiently flexible concerning the high speed direction.

Thank You!